



H175 Cervical Vertebral En Bloc Examination in Pediatric Deaths: The New York City Experience (2011–2019)

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Learning Overview: The goal of this presentation is to inform attendees regarding neuropathologic features of spinal nerve root hemorrhages and associations with other features of trauma, hypoxia-ischemia, or sepsis.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by illustrating that cervical vertebral en bloc dissection is a proposed means of detecting traumatic spinal nerve root injuries, hypothesized to lead to cardiorespiratory arrest in children suffering shaking and/or impact. Whether Cervical Spinal Nerve Root Hemorrhages (CSNRH) can occur because of hypoxia-ischemia, sepsis, or other non-traumatic etiologies is difficult to study prospectively, as the dissection technique is non-standard, invasive, and thus pursued only in deaths “suspicious” for inflicted trauma. The goal was to evaluate retrospectively the range of findings in all “neck block” specimens since the subject was first published in 2011 and whether traumatic and non-traumatic cases could be discerned.

Methods: All pediatric cases from 2011 to the present in which this technique was done were reviewed. The dates of birth, presentation, and death, as well as the findings from forensic autopsy, neuropathology, and microbiology, were analyzed along with final manner of death. Given the exploratory nature of this study, statistical methods were not employed.

Results: Over eight years, 43 infants and toddlers (age at death, 1 day to 3.25 years; median 5.3 months) were subject to this protocol because of suspicious or unknown circumstances. Twenty (46.5%) had bilateral, multilevel CSNRH, defined as hemorrhage *within* the spinal nerve root and/or dorsal root ganglion; specifically, 11 had *bilateral* involvement at C3, 4, and 5 (responsible for diaphragmatic innervation). Seventeen of these 20, as well as 12 other cases without bilateral multilevel CSNRH (i.e., 74.4% of the cohort), had other evidence of trauma, including scalp impact, skull/rib/other bone fractures, and/or blunt force abdominal injuries, and were ruled as homicides. Co-occurrence of bilateral multilevel CSNRH, Subdural Hemorrhage (SDH), and bilateral Retinal/Optic Nerve Hemorrhages (RH/ONH) was documented in 19 of the 20. Importantly, four of these cases had *no evidence* of head impact (scalp lesions, skull fractures). In addition to the 20 with bilateral multilevel CSNRH, another 4 had unilateral and/or single level involvement; among these 24, 18 (75%) had Hypoxic-Ischemic Encephalopathy (HIE), associated with resuscitation, life support, and survival >1 day; the remaining 6 of this subset died within one day, without time to develop HIE. Of note, four individuals dying within one day and, therefore, without HIE (3 with bilateral multilevel and one with single level SNRH) also had Amyloid Precursor Protein (APP) immunohistochemical patterns of traumatic axonal injury, further suggestive of torsional force injury to the brain. Among all individuals with HIE (N=29), 15 had bilateral multilevel CSNRH; 7 had very limited bleeding around nerve roots (including one infant with confirmed viral sepsis with bacterial superinfection, certified as natural), or foci of endoneurial hemorrhage in a single cervical level. The remaining seven had no hemorrhage whatsoever in or around nerve roots and did not have SDH or RH/ONH (including one infant with suspected sepsis, certified as natural). APP immunostains in 9 of 29 cases (31.0%) with HIE showed mixed patterns of single beaded axons in sites typical for traumatic axonal injury, as well as bundled axon staining typical of ischemia. Of note, however, was the fact that eight of these nine also showed bilateral multiple CSNRH, SDH, and RH/ONH, and were ruled as homicides on the totality of the evidence.

Conclusions: Over an eight-year period, this agency adopted “neck block” dissection in pediatric cases with unclear or suspicious circumstances at time of autopsy. Like all other data considered in death certification, neck block findings of bilateral multilevel CSNRH do not “stand alone,” but rather provide additional support for trauma, as they tend to cluster in the majority of cases with objective signs, such as scalp impact, skull/other bone fractures, and abdominal injuries. Particularly remarkable is that, in the absence of evidence of any head impact, bilateral multilevel CSNRH is associated with both SDH and RH/ONH and with markers of diffuse axonal injury, thereby supporting the role of fatal shaking as a mechanism of death. Nearly half of cases with HIE, and the small number of deaths due to sepsis, do *not* show this pattern of nerve root hemorrhage, arguing against non-traumatic pathogenetic mechanisms underlying this phenomenon. Finally, because of the apparent value of this technique to medical examiners in their work-up of suspicious deaths in infants and toddlers, this agency intends to continue its use.

Abusive Head Trauma, Cervical Nerve Root Hemorrhage, Child Abuse